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ABSTRACT

A study sought to determine the effect of computer-based text editing on the revision strategies of inexperienced writers. Four subjects, none of whom had experience with computers or word processors, were selected from an introductory college composition course and required to master the basic terminal functions that would be necessary for designing and revising a text page. Subjects gave the instructor an original, handwritten copy of an assigned essay with the topic, purpose, audience, and context defined. Subjects revised their essays on an AES-20 terminal with text editing keyboard and attached CRT unit and printer. During two of the sessions, the subjects were asked to revise as they provided a thinking-aloud protocol, while during the last session, the terminal screen was videotaped. Analysis of the strategies revealed during the revision sessions indicated that the use of the computer-based text editor increased the number and complexity of revision operations and encouraged greater manipulation of material at the word and phrase/clause domains, although this did not appear to affect the overall quality of the essays. The subject with the strongest writing skills excelled at the use of the computer for revision, while the subject with the weakest writing skills preferred more conventional methods of revision. (HTH)

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The Influence of Computer-Based Text Editors on the Revision Strategies of Inexperienced Writers

by Richard M. Collier

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INTRODUCTION

For quite some time I had considered myself lucky: I had in the fifties and early sixties been only amused at the inundation of the shores of science and society by the cumbersome gadgets called computers and their accompanying jargon, and I had escaped with a moderate drenching the tidal wave of computer assisted instruction in the early seventies. But the tsunami of recent times was to catch me up if not quite yet wholeheartedly, at least with some intensity. In the winter of 1981 I determined that I must try to master the intricacies of micro-computers and their languages. I began at this time occasional study of programming in the computer lab at the institution where I work. One day during this period, while I was strolling down the hall, I noticed that the name of the secretarial pool had been mysteriously transmogrified to the impressive title of Word Processing Centre. I was, of course, accustomed to cooks proclaiming themselves to be gustatory engineers, and so until I actually had an opportunity to enter this enclave, I paid no more than wry deference to this alteration. However, when I did finally visit our Word Processing Centre, I was surprised to find virtually nothing in the area that I recognized except the personnel and the coffee pot: instead of typewriters there were computer consoles, disk drives and a variety of printing devices. Obviously more had changed than the sign over the door.

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The supervisor was kind enough to demonstrate this equipment for me and to provide me with some introductory lessons on its operation. Soon I was something of a devotee, composing and printing my own reports, course outlines and the like on AES word-processing terminals -- and doing so, much to my own amazement, more easily and more quickly than if I had been writing by hand or using a typewriter. I also read a great deal during this time on the text editor/word processor revolution and discovered that quite a number of authors were, like me, praising the increases in efficiency they discovered when using these machines.[1] And so I thought, "If they and I can so benefit, then why not my students? What in fact might be the benefits for the teaching of writing of using word processors with inexperienced writers?" And from these questions emerged the present study (which is clearly but one of many possible) of the effects of computer-based text editors on the revising strategies of inexperienced writers.

BACKGROUND

There are clearly several types of revision that writers engage in and none of the types is entirely distinguishable from the others. In addition, some of the types are more easily measured than the others. Virtually impossible to observe is revision that takes place as a part of incubation and rehearsal, those purely mental activities which begin to shape the text as a phase of prewriting and which precede the production of hard copy. A second kind of revision occurs as a part of the composition of the actual text itself: many, if not most writers, continuously rescan what they have already written to recapture or reconfirm their sense of direction and to alter previous text if it seems not to correspond with that newly adjusted sense of direction. To go back and review text that has already been com-

posed is one of the primary means for determining how to advance that text from where one has left off; as well, if a writer wishes to alter the vector of his text, ongoing review and change of what has been completed is the only means of assuring appropriate coordination of parts. The future of a text depends to a large extent upon how we understand and thus adjust the past of that text.

The third form of revision is that of which most instructors of composition think when they hear the term: after a draft of a piece of writing is completed, often an author will return to it immediately or after some interval to review and rewrite it either in part or in whole. Clearly, the first and second forms of revision may also be included as sub-activities in this form: we rehearse and rescan as we rewrite.

There is also, of course, another dimension. Revision may take place either as an extremely complex and thorough "re vision" or "seeing anew", which reshapes an entire piece of writing, or it may deal simply with minute matters of word choice and placement (or even worse with matters of only graphological significance, in which case revision becomes recopying).

The present study examines primarily the third form of revision; that is, alterations to an already drafted text. However, as mentioned earlier, the other two forms of revision will influence this more dominant modality; the use of verbal protocols and videotapes allowed me to observe this influence to a limited extent.

Quite probably every instructor of composition has noticed at least intuitively that there appear to be vast differences between the ways in which inexperienced writers revise and the ways in which experienced or accomplished writers revise when they alter an already existing text into new copy. Simply stated, inexperienced writers do not do much to the text and what they do does not usually improve the text in any significant fashion; experienced writers, however, may perform what appear to be miraculous transformations on their text. Inexperienced writers seem to make the following assumptions about their writing and about the need for revision:

1. Writing is a form of transfer of meaning from inside to outside; once a

draft has been composed, what the inexperienced author wishes to communicate is now wholly outside of him/herself and is located in the graphic symbols on the paper. Therefore, revision is seen as the making of only minor adjustments to what is already on the paper itself; the thinking process and the thoughts themselves that the writing represents are felt to be already completed once the writing has been completed, and all that can be improved is the effectiveness of the communication of these thoughts. The inexperienced writer merely "fixes and patches" rather than seriously rethinks what has been written. Revision thus becomes a process of clarification at best, rather than of modification. In other words, after the draft has been completed, meaning is completed; it is seen as residing exclusively in the draft and no longer in the writer. Consequently, nothing remains to be discovered or explored (or so it seems), and all that is needed is to get what is now "out there" rightly worded.[2]

2. This earlier assumption has its corollary: if the meaning that was inside is, once the draft is completed, now outside, then the meaning that was inside must be identical to that which inheres in the words of the draft. We know, of course, that this frequently is not the case, that, in fact, what the writer has intended is not at all what his words convey. Linda Flower has explored most eloquently this distinction in her contrast between writer-based prose and reader-based prose. Nevertheless, most student writers when they re-read their drafts hear (or perhaps one should say "experience") their semantic intentions and do not actually read, as it really is, what they have written on the page. They experience a different meaning from that experienced by an external audience (who is uninvolved in an author's composing process except as a final recipient of her text) because they are projecting that meaning into their text, telepathically, as it were, from inside themselves.[3]

3. When students revise, they use some form of an implicit algorithm or rule-governed model for making even the few changes in wording and diction which they do. This algorithm varies for each writer, but probably for each it echoes to

some extent the prescriptive and proscriptive advice of English teachers and of rhetoric and grammar textbooks. Some of these rules may by wrong ("Never begin a sentence with a conjunction"), some may be silly ("Don't use 'I' in an essay") and some may be misleading ("Avoid the passive voice"); others, however, may be genuinely good advice ("Be clear and specific"; "Be concise"). The problem with all these rules, both the bad and the good, is simply that they are rules rather than heuristic paradigms, and inexperienced writers will apply them rigidly to their writing and to their re-writing without the necessary modifications which should be suggested by an ongoing assessment of the goals, context and audience for that particular composition. Is it any wonder that our students, beleaguered by trying to recall these rules and by trying to apply them inflexibly while revising or even while actually writing, make few improvements in their writing, lose interest in it, or, even worse, become paralyzed by anxiety?[4]

4. The immediately observable result of the three earlier points is that inexperienced writers are, when revising, primarily interested in alterations of the more minute aspects of a piece of writing, and are thus confusing revision with proofreading: their focus is on spelling, mechanical errors, inexact diction, and rewording problems[5] (this is what Nancy Sommers has aptly called "the thesaurus philosophy of writing").[6]

The revision strategies of experienced writers tend to be considerably different from those of the inexperienced writer. These authors, when revising, look at their text in order to discern its shape and structure, to discover the line of the implicit argument, and to find ways of adjusting what they have said to the expectations of audience and context. Often they will revise to discover new meaning in what they have already said, and their concern is frequently, if not primarily, with levels of discourse larger than the merely lexical. Their revising strategies are complex, individually unique, highly flexible, recursive, and holistic.[7]

Is there a way of measuring these differences between the revising strategies of inexperienced and experienced writers? Probably not completely since the strat-

egies of both types of writers will be quite idiosyncratic. Nevertheless, we can hypothesize that there will be noticeable and perhaps measureable differences between the experienced and the inexperienced writer in regard to the operations used when revising and in regard to the domains of the text upon which those operations are performed.

If one looks at revising as the alterations that occur from an earlier text to a later text, then there are basically only two operations that can be performed: addition and deletion. All other alterations are but variously complex sequences of these two operations. For example, substitution is simply a deletion plus an addition at the same place in the text; reordering is a deletion from one place in the text and an addition in another place of that which had been deleted; combination will be some form of deletion plus addition plus reordering with the delete operation emphasized; separation will have the same basic formula, but with the additive operation emphasized.

The domains of a text are its measureable and bounded semantic regions. It should be clear, however, that there is by no means uniform agreement about these boundaries; even within one text the determination of a particular boundary may be ambiguous. The most familiar designations for these domains, from smallest to largest, are as follow: graphic symbols (letters), punctuation, words, phrases, clauses, sentences (or, more appropriately for this study, T-units), meaning chunks (clusters of related ideas), paragraphs, and stadia (groups of paragraphs).[8]

Because of the complex layering and the resulting ambiguity of interpretation that can occur with the operations of combination and separation, I restricted my attention in this study to addition, deletion, substitution, and reordering. As well, because the domain of graphic symbols is with typed copy concerned only with spelling and because stadia were domains generally equivalent to the entire texts

produced by my subjects, I omitted these dimensions from my research. Phrases and clauses were included as one domain since the boundary dividing them is rarely determined with ease. Sentences, as mentioned earlier, were interpreted to mean T-units.

We can combine operations and domains into a rectangular matrix:

OPERATIONS	DOMAINS: Punctuation	Word	Phrase/Cl.	Sentence	Mng. Chunk	Paragraph
Addition	**********	**********	**********			
Deletion	**********	**********	**********			
Substitution						
Reordering						

Inexperienced writers tend to confine their revising strategies to the areas in the matrix indicated by the asterisks. Experienced writers possess strategies that encompass the more demanding of the operations and which expand concern to the larger domains. One might hypothesize, therefore, that the fewer cells of the matrix which a writer's revising techniques intersect, the less mature and effective are those techniques; conversely, the more cells of the matrix which a writer's revising techniques intersect, the more mature and effective will be those techniques. In effect, one of our tasks as instructors of writing is to help our students expand the matrix of their revising strategies.[9]

Additionally, I theorized that there might also be other, related problems which could inhibit inexperienced writers from adopting a more complex, holistic and mature set of revising strategies:

1. Addition, reordering and sometimes substitution, when applied to the larger domains of a text, may overstrain a student's conceptualizing powers which are already taxed to some extent by matters of diction and proofreading, matters which a more experienced writer might solve automatically and unconsciously.

2. Higher order revision strategies place great demands on both short and long term memory. Experienced writers are those who have learned to juggle successfully these demands.

3. Inexperienced writers often labor under the assumption that to make major alterations in a text is to risk destroying or negating that which had originally been written, thus making its retrieval for later consideration virtually impossible. One of my students put it this way: "I think this paragraph could probably be improved. However, at this time I am not sure how, so I thought it was better to leave it, rather than take the chance of messing it up." Thus we can see that many inexperienced writers operate upon an implicit model of the composing process that equates writing with speech.

4. For all of us, experienced and inexperienced writers alike, to revise means at some point to recopy. It follows, then, that the fewer changes made and the smaller the order of these changes, the easier and quicker will be the task of recopying. With higher order alterations (at the meaning chunk or paragraph level, for example) recopying can become quite time-consuming, particularly if significant revision required several reshapings, false starts and dead ends, each of which demanded a new draft. Student writers may see, at least intuitively, that complex revision practices will require an exhausting amount of time and effort, some of it unproductive and virtually wasted since it is, for the most part, only mindless recopying. Thus, there would seem to exist a strange logic that says, in effect, that the less that is altered in the text the easier will

be the recopying.

And now we return full circle to the use of the computer-based text editor. My own experience of working with this equipment suggested that it helped a great deal in actual first-draft composing and even more so with revising. The reason for this apparent benefit was the ease with which various operations could be performed. For example, one can insert letters, words, phrases, even sentences and paragraphs into a text quite simply; as well, one can just as easily remove these same items; a piece of the text can be altered by positioning the cursor and typing over what was originally on the page; small and large chunks of text can be moved to different positions within a sentence, on a page or even from one page to another; every alteration can be stored in the terminal's memory and is therefore available for immediate recall.

Encouraging students to work at their writing, particularly draft to draft revision, on a word processor/text editor would, one might guess, resolve most of the problems mentioned previously. The word processor would, for example, because of the ease with which revision operations can be performed, supplement rather than strain the writer's conceptualizing powers. Since the word processor possesses elaborate memory functions, all drafts and alterations could be stored and recalled at will, thus making the recopying of any portion or of the entire paper in a variety of formats nearly effortless. In addition, a word processor has attributes that might make revising an attractive activity: because it is essentially a computer, a word processor contains within itself the capability of novelty which could encourage the writer to play with language; those experiments might, especially for the inexperienced writer, promote surprise, innovation, even serendipitous learning, all of which are essential ingredients of productive heuristics. In other words, the word processor/text editor might, along with improving revision strategies, also stimulate creative problem solving.

HYPOTHESIS

That the use of computer-based text editors will significantly expand the number and the complexity of the operations used by inexperienced writers when revising and will increase the range of domains upon which these operations are performed, thus improving overall the effectiveness of their revising strategies.

METHOD

Participants: Four subjects were selected from an introductory composition course at Mount Royal College, a two-year post-secondary instituion. All four were female nursing students, whose ages ranged from nineteen to thirty-two. All could type but only two were judged to be superior touch typists; none had had experience with computers or word processors before this experiment. The subjects were selected on the basis of several writing competence activities from a group of about thirty applicants; two subjects possessed average writing skills, one possessed weak skills, and one superior skills.

Equipment: Each participant used a stand-alone AES C-20 terminal with a text-editing keyboard and an attached CRT unit. The shared printer (one for each two terminals) was a Qume model S3/45 with interchangeable printwheels and a model SP/FD automatic paper feeder. Memory was encoded on a standard AES C-20 floppy diskette.

Design: All subjects were required to master the basic terminal functions that would be necessary for designing the text page and for revising that page: vertical and horizontal margins, character spacing, line spacing, movement of the cursor, erase, delete, insert, movement of chunks of text, character repeat, page break, creating workspaces, opening workspaces, memorizing text, recalling text, updating text and printing. Many of the functions of which the AES word processor is capable (such as, justification, tab to block, list/merge, and embedded codes)

were irrelevant to this experiment.

Except for the last session the participants were requested to turn in to me on each Tuesday an original, handwritten copy of an essay that had been assigned the previous Friday. In each instance four rhetorical variables were defined for the subjects so as to provide some degree of homogeneity in the kind of writing produced for each session. The constraints were designation of topic, purpose, audience and context. For example, one assignment asked the subjects to persuade an audience of female students in favor of trial marriage and to do so as if they were writing an editorial in the student newspaper.

All the revising sessions took place on Friday afternoons from two until five. The subjects worked on paired terminals, sharing a single printer, and generally had about an hour for their revision tasks.

During two sessions I asked the subjects to revise while providing a thinking aloud protocol. Briefly, a thinking aloud protocol is a record of what goes on in a subject's mind while performing a task. In this instance, each subject was asked to speak aloud into a portable tape recorder everything, no matter how seemingly irrelevant, that came to mind while revising. Considerable research has demonstrated that the taking of a protocol does not seriously influence what is thought or said, if the subjects are adequately briefed and trained in this procedure ahead of time. In the case of the present experiment my subjects had been provided with two training sessions prior to the taking of the first experimental protocol. As well, research has suggested that these verbal protocols do in ract provide a fairly accurate record of what the subject is thinking while actually engaged in a task. Thus a verbal protocol gives the researcher access to information that would not be available if he were simply to make reference to the finished product and attempt from it to infer the cognitive activity that helped to create the product.

During the last session I had the terminal screen videotaped. An analysis of this visual record allowed me to see what actually went on while the subjects were revising, again permitting me access to data which would not have been available had I only compared original and revised drafts of the written work.

It should probably be noted that I was very careful not to reveal to my subjects either my intensions or my expectations for the results of the experiment. Because they were unable to guess what it was I might have wanted, the actual results were probably not significantly contaminated and do, therefore, reflect their actual revising processes.

Critical Path:

Session I: The subjects revised in the normal, traditional format by altering the text on the original hand written copy and/or rewriting the altered text on clean paper. A comparison of the two drafts provided me with a profile of the subjects' normal revising strategies.

Session II: The activity of this session was procedurally identical with that of Session I, except that in this instance the subjects provided the first set of verbal protocols.

Session III: The subjects encoded their handwritten drafts into the memory of the word processor and then performed on-screen revisions, producing a finished, printed text at the end of the alloted time. All four subjects had been trained in the use of the terminals prior to this time.

Session IV: This session was identical to Session III except that again, as in session II, I took a verbal protocol from each subject as she revised.

Session V: In this session, I encoded the subjects' handwritten drafts into the memory of the word processor prior to the commencement of the revising activity. The subjects were then able to call up the first page of their orignal draft and begin revising.

Session VI: Session VI was identical to Session V except that the CRT was videotaped during each subject's working period, and the subjects were asked to revise a revision of one of the earlier five essays (selected by the experimenter); in other words, one of the five essays for each of the subjects was revised twice during the course of the experiement.

ANALYSIS

Because of an unexpected curtailment of funding, I was unable to attach control groups to any of the sessions of the experiment. As well, because I was unable to get uninterrupted access to the word processing centre, occasional intrusions and distractions did occasionally interfere with the concentration of the subjects. There were also one or two minor equipment failures during the course of the experiment. These limitations were unfortunate, but not serious.

Additionally it was necessary for me to perform the analysis of the data entirely by myself. At first I had been concerned about the problem of bias in the analysis, and would have preferred to have had several analysts, each performing the same tasks which then could have been correlated for inter-rater reliability. But such was not financially feasible, and in the long run I think it probably did not matter that much. The analysis of revision strategies is basically straightforward once one has defined the operations and domains fairly consistently: deciding if something has been added or deleted and determining the size of that something are not particularly demanding tasks. What I am suggesting here is that the measurements were sufficiently coarse and objective, and there were sufficiently many of them, that it is doubtful if undetected biases had any effect on the experiment.

The analysis, then, consisted of identifying the operations used and on what domains in each revision for each subject they were used, counting these items, and then recording them on matrix charts. I subsequently performed a variety of statistical comparisons of these charts in order to derive generalized trends.

RESULTS

Experimental Hypothesis: The hypothesis that the use of computer-based text editors will significantly expand the number and the complexity of the operations used by inexperienced writers when revising and will increase the range of domains upon which these operations are performed, thus improving overall the effectiveness of their revising strategies was, generally speaking, not confirmed. It will become evident later in the particulars of the results that many aspects of this hypothesis were confirmed at least to some degree, but that these subsidiary successes do not add up to confirmation of the hypothesis as a whole.

Operations: The use of the computer-based text editor for revising purposes appears to have a distinct advantage over the traditional handwritten-transfer format for three of the four operations investigated. The subjects made two-thirds fewer deletions when using the text editor, two-thirds more substitutions, and engaged in twice as much reordering. Surprisingly, subjects made on the average slightly fewer additions to their papers using the text editor than when revising in the traditional mode. The variation among the subjects was, however, so marked as to make this result rather problematic: two subjects performed more additions using the word processing equipment, one significantly so, while two performed significantly fewer additive operations with this equipment.

Domains: The use of a word processor appears to encourage greater manipulation of material at the word and phrase/clause levels than does the traditional format (66% and 50% more for the word and phrase/clause domains respectively). There was little difference between the two methods of revising for the levels of punctuation, sentences, and paragraphs. Revision by the traditional method is superior to revision by means of a word processor at the level of meaning chunks.

Matrix Analysis: If we analyze the matrix itself instead of the vertical and horizontal dimensions separately, we find the following results: the subjects added phrases and clauses, sentences, and meaning chunks more effectively when they revised in the traditional mode (one subject added and deleted extensively at the paragraph level); the subjects substituted words and sentences more proficiently when using the word processor. All the other squares in the matrix (nineteen out of twenty-four) had scores similar enough to make any kind of distinction in favor of one method of revising over another virtually impossible.

Length of Paper: Each original essay averaged 425 words, and the revisions in both modes increased in length. However, three of the four subjects produced more words in the revised copy than in the original draft when using the word processor than they did when they revised in the traditional mode (approximately 39 words more). One subject (the weakest of the group in composing skills) consistently deleted more than she added in her revisions. None of the subjects reversed a trend set up when revising in the traditional mode: if a subject made net gains in the word count in an essay while revising with the word processor, that subject had also made net gains while revising traditionally. The converse was also true: the subject who tended to delete while revising in the traditonal mode, also did so on the word processor.

Surface Structure Errors: When revising in the traditional format, three of the four subjects carried forward surface structure errors (spelling, punctuation, and syntax) from the original draft to the next (a mean of 4.0 repeated errors), and added new errors to the revised text (a mean of 1.63 additional errors). When revising with the word processor, all subjects carried forward surface structure errors (a mean of 5.25), and also added new errors to the revised text (a mean of 2.4). A comparison of these means would suggest that the subjects on the

whole were somewhat (but not significantly) less careful of surface structure when using the word processor. This conclusion is reinforced when we note that fewer (but very slightly so) surface structure errors were corrected when revising with the word processor than when revising in the traditional mode.

Use of Preprogrammed Copy: Sessions III and IV were compared with sessions V and VI. In the first set the subjects had been required to program their essays into the computer terminals themselves and then revise. In the second set I had entered their essays into the memory disks so that the subjects could sit down at the terminal, recall the first page of their essay and begin on-screen revision. The first method promoted more additive operations and more manipulation of punctuation, sentences, meaning chunks and paragraphs; but in none of these instances was the advantage significant. The preprogrammed method favored the operations of deletion, substitution, and reordering and the manipulation of words and phrases/clauses. However, only with substitution and the domain of words was the difference significant. This analysis suggests that preprogramming may make revision on the word processor more efficient, but not necessarily more effective.

Protocol Analysis: An analysis of the verbal protocols taken during the experiment, one with the traditional method (Session II) and one with the word processing format (Session V) essentially confirms the preceding statistical results, but goes beyond to indicate that simple mechanical ability may be a deciding factor in a subject's success or failure to use a word processor effectively for revision purposes. The subjects with the weakest typing and text editing skills were the least happy and least successful. Those, however, who in effect "subdued" the terminal and became adept at its use found that revising on the word processor was easy, efficient and quick. These rather subjective conclusions are reflected in the type of statements made during the second protocol son. Beyond this, the comparison of the protocols taken during the

two sessions suggests that the revising strategies of the subjects were not essentially different when using the word processor from when they were engaged in the traditional mode, except that they did more of what they normally did and focused on substitutions at the word and phrase/clause levels.

Analysis of the Videotapes: The analysis of the videotapes of the CRT's during this last session added several new and interesting dimensions to the investigation. For example, the average number of moves detectable on the screen (including the cursor) was 3.6 per minute per author, whereas the number of moves that actually altered the text was 2.55 per minute per author. However, a comparison of drafts (original with final copy) reveals only 0.38 detectable alterations per minute per author (this is a figure which almost identical to the average number of detectable alterations per minute per author when revision is carried out in the traditional mode). What this suggests is that a great deal more is going on during the revision process when using the word processor than a simple comparison of drafts would reveal. In other words, revision is layered when the writer is working with the word processor: revisions are made over other revisions; revisions are enacted and then deleted (sometimes several times), so that as a consequence no observable record of these changes can be found in the final copy; many revisions are merely contemplated (by depressing the insert key, for example, viewing the resulting blank line, and then closing up the blank line by using the cancel command); and revisions may be layered in cycles in the sense that most of the subjects who worked through the draft line by line went, when they came to the end, back to the beginning of the draft and started the process again, making revisions upon revisions as they cycled over the text a second and occasionally a third time. It seems safe to conclude that more is being contemplated and experimented with when the word processor is being used even if the final product does not necessarily reflect this activity in a significantly improved piece of writing.

This visual analysis certainly confirms in part the earlier statistics: insertion is the dominant command (this can result in either addition or substitution) for all subjects, and this command is used primarily in the word, phrase/clause and sentence domains.

It became quite clear after viewing only a few minutes of the videotapes that the attention shifts needed when manipulating the keyboard for the operations other than simple typing interrupted continuous concentration on the text itself. Several sequential keyboard moves are required to accomplish one revisional alteration; for example, to substitute one must depress the insert key, type in the change, strike the cancel key, and then delete that part of the text no longer needed, a command which itself may be made up of several sub-commands. Without excellent text editing skills, this complexity may make revision with a word processor more stressful than revising by hand.

The subjects' attention was clearly not focussed only on the minute concerns of punctuation, grammar and diction, although they often rescanned short sections of text to proofread and correct what had already been revised. Instead, their attention seemed to be directed at the domain of the meaning chunk. Larger overviews were rarely included, however: the page or the paper as a whole was almost never scanned. One can readily see why this did not occur more frequently: the screen held only about half the page and complex scroll, store and retrieve operations were necessary to recall successive or preceding pages of a text.

Analysis of Quality: Extensive tests for changes in the quality of drafts from the original to the revision were not planned as part of this experiment; however, I did undertake informal assessments of the qualitative differences. Generally speaking, no clear difference in quality between the original and the revision could be found during either the traditional sessions of revising or the

sessions of revising using the word processor. In other words, even though there may be some increase in efficiency and in experimentation when revising on a word processor, there does not seem to be a comensurate increase in the quality of the revised product. This result probably reflects the fact that most of the revising activity occurred at the word and phrase/clause domains and was, therefore, concerned primarily with matters of diction, many of which were probably trivial. Editing in the smaller domains does not seem to add much to the effectiveness or quality of the final product. In fact, except for the one subject who was already an extensive and careful reviser, even those essays revised twice failed to improve much in quality. Most of the subjects throughout the six sessions made alterations which all too often were minimal, insignificant or even detrimental.

Analysis of Variation in Subjects: One subject clearly preferred and worked well with the word processor, while one strongly favored the traditional method; the other two had styles which were sufficiently mixed that they seemed to revise with about equal facility with either method. The primary correlation here was that the subject who excelled at using the word processor for revison was also the subject whose writing had, under the original conditions of test selection, been evaluated as superior, while the subject who preferred the traditional method was the one with the weakest composing skills. The careful and extensive reviser showed improvement when using the word processor in seven of the ten domains and operations and fourteen of the twenty-four matrix cells; the weakest writer of the group improved in only one category (punctuation) and only four of the matrix cells. The other two subjects improved in five of the

domains and operations; only three of these were the same for both subjects (substitution, reordering, and words). One of these two subjects improved in eight of the twenty-four matrix squares, while the other improved in six.

All this seems to suggest two conclusions: 1. Three of the four subjects seemed to have improved their revising strategies at least slightly when using the word processor. 2. As so frequently happens, the superior student will excel in a new and stimulating environment and the less able student will be overwhelmed by this same environment and resort to habitual, but less productive methods of problem solving.

Subjects' Evaluations of the Experiment: One might guess from what has been said heretofore that the reactions of the subjects to revising on a computer-based text editor might be somewhat negative, or at best rather mixed. Such was not the case, however. Except for the one student who consistently had difficulty with learning how to use the equipment, the student subjects seemed in their evaluations to be far more positive about their experiences than I would have expected.

But let us note first some of the negative comments. Most of the subjects agreed that more time was necessary to master adequately the complexity of the machinery and achieve an appropriate degree of virtuosity in its manipulation. The terminals were not built to be easily used by inexperienced students and their complexity led frequently to frustration and a drain on intellectual and emotional energy. The fact that all but the current page of a text was invisible made thinking of the composition as a whole quite difficult, and thus equipment which I had hoped would encourage a more holistic view of writing instead seemed to encourage greater fragmentation.

One of the advantages of using a text editor is similar to that found when students learn to use typewriters for composing and revising: the clarity of the printed text displayed on a screen directly in front of the author as opposed to a less legible handwritten text resting beneath eye level on a table was noted as a major virtue of working with this equipment. Several comments indicated that the screen permitted a more accurate (although still partial) overview of their work and that the machine facilitated easier contemplation of and comparisons among revision alternatives. Two subjects added that they were less likely to become enamored with their own texts when using the word processor; they were thus more realistic about what was actually on the page, and engaged in what they felt were more productive revising activities.

The subjects stated that lockout time (the time between giving a command and being able to procede with the writing activity -- the greatest gap being for printing) was a positive feature; rather than serving as an interruption to concentration, it provided a desirable pause for rescanning and incubation. This was but one of the features that seemed to prompt several suggestions that composing directly on a word processor might have positive results.

Three of the subjects remarked on the pleasant novelty of working with the word processor, adding that the equipment was fairly easy to use and seemed to them to increase their revising efficiency.

DISCUSSION

What conclusions can we legitimately draw from these results, as mixed and ambiguous as they often appear to be? Certainly I think it is safe to reassert that the original hypothesis was not confirmed, although there are subsidiary particulars that escape this overall evaluation. Let us look, then, at those aspects of the hypothesis which can be viewed as being either supported or denied, and see to what conclusions this leads us.

On the positive side:

1. The number and complexity of operations employed for revision increases when the subjects use a text editor.
2. A text editor facilitates the manipulation of written material at the level of words and phrases/clauses.
3. The length of essays increases slightly when revision takes place on a text editor.
4. Subjects engage in more revision activity when using a text editor.
5. Using a text editor is clearly an advantage for the superior student and is of some value for the average student.
6. Most of the subjects reacted positively to their experiences with a text editor.

On the negative side:

1. The use of a text editor does not facilitate the operation of addition (it does, however, reduce deletions).
2. A text editor has little or no advantage over the traditional mode of revising for most of the domains of a text.
3. The number of surface structure errors is not reduced when a text editor is used, and in fact increases slightly.

If the text editor is to become aul part of a college or university writing program, the following problems will have to be solved:

1. Despite my subjects' protestations to the contrary, I feel that the lockout time will need to be reduced since such an interruption may well have been a distraction from deep and continuous focus on the written text.
2. The word processor may encourage one to concentrate attention on the smaller domains by making minimal alterations (those, say, at the word and phrase/clause levels) easy to accomplish and by making larger alterations (the reordering of meaning chunks, for example) more difficult. Thus subjects become entranced by the superficial, and rather than performing concientious overview planning, they play with the word processor somewhat as if it were a game of Atari space invaders, never quite taking it as seriously as they might.
3. The word processing equipment which we used (the AES C-20) was extremely sophisticated and complex. As well, since it was intended exclusively for the modern office, it included a great number of supervisory operations and format concerns which were largely irrelevant to the needs of my subjects, but which may in fact at the same time have interfered with their revising activities.
4. It seems reasonable to surmise as a result of these three concerns that if the word processor is to become a useful part of the writing lab -- and I believe it will, -- then it must be redesigned for the needs and purposes of this environment. For example, editing will have to be made at least as easy, quick and efficient as by hand; split screens and high and low focus options will be necessary; memorize and recall functions must be simplified and included with some form of infinite vertical

scrolling. Integrating the word processor with software that could scan a text and highlight possible errors in spelling, punctuation and basic syntax would be a distinct advantage. What is needed is a system that is far more "user-friendly" than the system with which we worked.

5. Students themselves will have to become significantly more computer literate than they generally are at this time. When this occurs, the training they will need for operating a word processor will be reduced and they will be more likely to treat the terminal as a tool rather than as a game, and then be more capable of using it successfully for both revising and composing.

This report suggests that it is feasible to use word processors to aid revision and perhaps to facilitate direct composing since the word processor, even given its present limitations, still produces at least some positive results for both the experienced and the inexperienced writer. It would seem capable therefore of doing considerably more in the future, especially since the technology to create the hardware and software appropriate for the needs of our composition students exists at this moment. There may come a time when students of writing dispense almost entirely with the traditional format of pen and paper, substituting in their places a keyboard, a computer, and a printer. They may also be able to modify their reliance on the grammar handbook, dictionary, and thesaurus by using programs that prompt, highlight, correct, analyze and compare their drafts. The terminal may be able to assess the relative readability and syntactic strength of different versions of the same paper, and simplify the process of research by providing electronic access to card catalogues, microfilm, and interactive television learning systems. Whether or not this is too visionary a portrait remains, of course, to be seen. Nevertheless, the writing lab of the future will undoubtedly contain among its many surprises some form of the micro-computer and text editor, and we might be wise to plan today for that not-so-distant tomorrow.

NOTES:

[1]See, for example, Writer's Digest, April 1981, pp.21-30; Jerry Pournelle, "Writing with a Microcomputer," onComputing, 1, No. 1 (Summer 1979), pp. 12-19; Milton A. Rothman, "The Writer's Craft Transformed: Word Processing," onComputing, 2, No. 3 (Winter 1980), pp. 60-62; and Jerry Pournelle, "A Writer Looks at Word Processors," onComputing, 2, No. 1 (Summer 1980), pp. 83-87.

[2]Nancy I. Sommers and Ronald Schliefer, "Means and Ends: Some Assumptions of Student Writers," Composition and Teaching, 2 (December 1980), p. 70.

[3]Linda Flower, "Writer-Based Prose: A Cognitive Basis for Problems in Writing," College English, 41, No. 1 (1979).

[4]Sommers and Schliefer, p. 75. See also R. Baird Shuman, "Theme Revision? Who Needs It?," Peabody Journal of Education, 40 (July 1962), pp. 12-15.

[5]Sommers and Schliefer, pp. 70-71.

[6]Nancy I. Sommers, "Revision Strategies of Student Writers and Experienced Adult Writers," College Composition and Communication, 31, No. 4 (1980), p. 381. See also Richard Beach, "Self-Evaluation Strategies of Exensive Revisers and Nonrevisers," College Composition and Communication, 37, No. 7 (1967), pp. 677-81.

[7]Sommers, "Revision Strategies . . .," pp. 384-86.

[8]Some of this nomenclature was adapted from Nancy I. Sommer's article cited in note #6.

[9]Of value for further reading is the following research article on revision: Lillian S. Bridwell, "Revising Strategies in Twelfth Grade Students' Transactional Writing," Research in the Teaching of English, 14, No.3 (1980), pp. 197-222. I have also found very useful two other texts: Gillian H. Crowley, "The Synergy Between Revising and Composing in the Total Writing Act: A Case Study of the Revision Processes of Three College Students," Unpublished master's thesis, University of Calgary, 1981, and John D. Gould, "Composing Letters with Computer-Based Text Editors," Research Report RC 8446 (#36750)(Computer Science), IBM Research Center: Yorktown Heights, New York, 1980.

Please note: It is perhaps worth mentioning that I composed, revised and printed this article entirely on an AES C-20 word processor.